



Performance from Experience

Business Challenges and Opportunities In Tomorrow's Mobile Networks

White Paper

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"May you live in interesting times".

This old adage may be particularly apt as the mobile industry moves into a new age. But what will be most "interesting" about our industry's future?

- Will it be the ability of 3G¹ radio standards to enable higher data rates and improved spectrum efficiency?
- Or the move to a "next generation" IP-based packet network?
- Or the advent of a "mobile Internet" characterized by a profusion of voice, data and short mobile commerce transactions, as opposed to a network dominated by nearly identical voice calls?

The answer, of course, is "all of the above", and more. In fact, one of the most disruptive impacts on our industry is almost too obvious and seemingly benign to mention: Success.

Growth: the hidden business driver

Our success at attracting new subscribers, and in driving ever greater usage, is transforming the mobile industry profoundly. Explicitly, it drives our business volumes and (hopefully!) revenues ever higher. Implicitly, it drives larger call centers, more cells and sectors, and exponential growth in the core transport and switching network. And at a third level, growth transforms the economic structure of the mobile business – driving management focus from "Average Revenue Per User" toward more efficient use of its capital investments – most importantly those in spectrum, services, brand management and the network.

¹We will use "3G" broadly here, to define the emerging mobile technologies that will allow for a wider range of services, but mostly for efficient provision of data services, in the near future. This is likely to include both 2.5G and 3G radio standards, as well as the emergence of packet-based (IP, ATM) core networks that are cost effective and flexible for data and transaction services.

Success has also changed customers' expectations – and thus their service demands. In Europe, and more recently in the USA, mobile communications has evolved from "luxury" to "necessity"; first as a business tool, and later for personal communications. Consequently, users are selecting their operator as much for service quality, reliability and service richness as they once did for price and coverage. This translates into a new urgency to provide high quality and innovative services (as the customer perceives them) at competitive prices. A neat trick, but one that will separate winners from losers in the highly competitive mobile future.

***The market environment: more growth and increased competition:
"no rest for the weary"***

Looking forward, among all the change and uncertainty, there are a few things of which we can be fairly certain:

1. Continued growth in mobile usage, and the gradual substitution of mobile for fixed communications, mostly for voice and mobile internet services.
2. Competition will increase as build-outs and new spectrum allocations increase the viability of many operators.
3. Customers will demand ever more quality, coverage, capacity and service variety at ever lower unit prices.
4. New technology and proliferating services will render operations vastly more complex, yet more financially rewarding.
5. Basic geographic coverage will cease to be a major differentiator, even in the USA.
6. Subscribers will demand truly seamless mobility, including seamless roaming and transparent availability of services – over a wide geographic range.

Taken together, these six "safe predictions" suggest that our industry must apply innovation and new technology to lure customers, and to keep our costs competitive. Nothing unusual there. But what may be unusual is the degree to which the mobile industry, far more than fixed networks, is beginning to resemble a highly competitive consumer goods market. This suggests that technology and innovation must evolve from the radio domain to innovation in services, enabled by sophisticated core networks and operations.

***From voice minutes to the mobile internet
Or, "it's the services, stupid"***

In the 1992 US presidential campaign, one political advisor summed up the winning formula to then Governor Clinton: "It's the economy, stupid". In the evolving mobile world, technology becomes the enabler, but we must also remind ourselves that from a customer, revenue and differentiation perspective "it's the services, stupid".

Traditionally, mobile network traffic has been dominated by voice. Although GSM in particular provides for comparatively rich services, the majority of revenues and network traffic have come from subscription-based voice services.

Even prepaid, recently the engine of subscriber growth across Europe, typically yields substantially less traffic and revenue per subscriber than traditional subscriptions. Clearly however, an array of differentiated services are beginning to emerge, and this trend will only accelerate in the near future. It is already clear that pricing options – far more creative than simple pre and postpaid – will proliferate, and that message services – as in the case of Short Message System (SMS) services – can tap into new needs and new markets.

Today's prepaid and SMS services are two early innovations in what is likely to become a creative flood. They offer practical insight into the types of innovation that will make for profitable, successful competitors in tomorrow's world. Prepaid is a perfect example of innovation in pricing. The basic service and technology, for example GSM telephone calls, do not change, at least from the subscriber's perspective. But the pricing methodology changes drastically, and consequently draws a wider range of consumers and their revenues.

Conversely, SMS services show how a fundamentally new service can drive new types of usage and appeal to new demographics. SMS services not only create incremental revenues from existing voice customers, they also drive usage by the teenage demographic, who are far more price sensitive than traditional mobile subscribers, and also show less hesitation with odd typing requirements. Japan's i-mode service suggests that in the future, the mobile market may succeed by supporting a huge array of services that traditional operators have never considered; each targeted to specific niches. i-mode truly demonstrates that services and diversity are truly a winning formula. WAP, on the other hand, has demonstrated that radio coverage with a paucity of content, is not.

With penetration rates moving towards the 100% limit (or, some would argue, beyond) we are witnessing the beginning of a shift that occurs in almost every industry; the shift from "mass production" to so-called "mass-customization". As technology and economies of scale enable cost effective niche product and niche marketing, nearly every product or service imaginable can be offered; each at many price and quality levels, and with payment plans to suit individual needs. For example, we no longer consume identical Model T Fords² and Volkswagens. Rather, the auto industry has segmented along many axes, only one of which is price. Lifestyle marketing drives segmentation along size, personal style, sport, luxury and a host of other axes, and plays a major role in targeting the specific needs that cause customers to part with significant sums of money.

Consequently, service richness will be the true legacy of 3G. While the basic technology will enable "always on" internet access, higher speeds and more efficient data transport, it is the flexibility enabled by 3G networks that holds out the greatest revenue potential, and poses the most significant technological and operational challenges to a mobile operator.

It is a fundamental tenet of economics that consumers (whether they are individuals or businesses) place different value on goods like cars, jewelry or communications services. Some people will spend lavishly to be early adopters, or to have

²The only model car produced by Ford in the early 1900s, of which Henry Ford quipped people could "have them in any colour they like, as long as its black".

superior service, while others are far more price sensitive. Operators – like automakers – maximize both their revenues and profits when they target a range of offerings to individual niches.

Market research (and the history of nearly every other good and service) suggests that differentiation will occur on more than just price. In fact, the most basic differentiation will occur based on content. Some people will want travel information; others financial information; others entertainment and messaging. Each of these is basically a data transaction, yet they are differentiated by content. But differentiation and customization will certainly not be limited to content. We expect further refinements in "quality", performance, pricing, and ancillary value-added services, such as security.

The table below illustrates our view of service richness "today" and "tomorrow", recognizing that "3G" is not an individual event. Rather, it is a gradual migration of technologies (RANs, core networks) and services from today's GSM or IS-41 voice networks, through stages of 2.5G and mixed networks, and ultimately to tomorrow's "all-IP" UMTS/CDMA2000 packet networks.

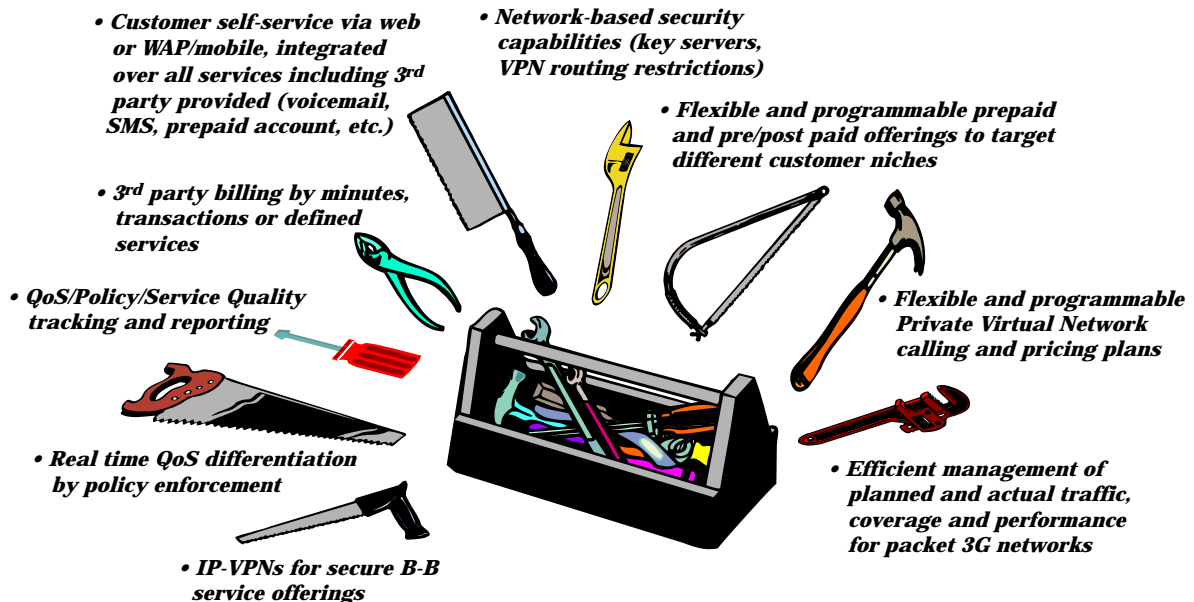
| <i>Today / 2G</i> | <i>Tomorrow / 2.5G / 3G</i> |
|---|---|
| <i>Voice Dominates</i> | <i>Voice, email, location-based, financial transactions, WAP, messaging</i> |
| <i>Minutes, Messages</i> | <i>Per-transaction billing, Value added enablers, security, guaranteed QoS, micro-billing, content-based charges</i> |
| <i>Subscriptions and Prepaid</i> | <i>Subscriptions, integrated Pre-Post Paid, PVNs based pricing plans, Priority access, discounted (non-priority) access, Data and content Prepaid</i> |
| <i>Coverage</i> | <i>IP-VPNs, SLAs, "gold/silver/bronze" 3rd Party Content!</i> |
| <i>Simple Mobile Phones</i> | <i>Complex, software driven mobiles</i> |

Success in 2.5G & 3G lies not just in deploying exciting new technology, but specifically in deploying a network and service creation infrastructure that is both cost effective, and capable of delivering – over time – the range of services described above. Interestingly, the greater the range of services offered, and the greater the range of quality and price options, the more efficient (and cost effective) the use you are likely to make of your network resources. While this may sound counter-intuitive, in fact, the communications industry in general (and the mobile industry in particular) have a long history of employing "off-peak" pricing to encourage use of an otherwise under-used network; to discourage peak-hour congestion; and consequently increase revenues. In the 2.5G & 3G packet environments, we will have a far richer set of options available, and consequently can build a richer – and better differentiated – set of end user services.

Business Challenges and Opportunity In Tomorrow's Mobile Networks

But having the raw technology does not automatically lead to new services. For operators to actually create and administer these services, they will need a core set of tools to manage their network and services – and to do so profitably. Fortunately, a large set of services can be created from a relatively smaller set of basic technology features, and these can be managed by a correspondingly smaller number of management tools.

The following illustration provides one view of the core tools required to operate a packet-based, multi-service, 2.5 or 3G network.



One well-founded fear in our industry is that 2.5G packet networks, and especially 3G networks and technology, are new, unproven and not yet understood sufficiently. Certainly we must be very cautious of unproven technology, particularly in the radio propagation domain where there is no substitute for deployment and empirical evidence. Yet other aspects of 3G – while still relatively new – are not totally untried. The basic packet technology of 3G (and, for that matter, GPRS/EDGE), employing ATM and Frame Relay for capacity provisioning and IP for transport and routing, is being deployed today in fixed networks. Of particular interest are those deployments where predictable or guaranteed performance is required, and where "contention" for capacity is high. These are emerging today, in the form of ATM and IP networks deployed to support xDSL (and Voice over DSL), Cable Modems, VoIP and business-to-business extranets such as the Automotive Network eXchange (ANX).

Beginning in 1996 Telcordia Technologies began engineering and planning for what we called "Next Generation Networks", or "NGNs." NGNs are fundamentally high speed, multi-service packet data networks capable of supporting the traditional functions of voice networks, data networks/internets, and even mobility by providing quality-assured transport, switching and services over IP and ATM cores. In effect, they are feature-rich, reliable Internets.

By contrast, few IP networks today have the reliability, QoS, or voice features to meet regulatory and business demands. Given that plain old voice is among the most demanding (and profitable) services on an IP network, the Telcordia objective was quite simple: bring PSTN-levels of quality, services and reliability to Voice Over IP (VoIP) for our clients. Unlike some of the demos, enterprise and internet VoIP services that dominate the news today, our clients are deploying regulated-quality telephone service on a variety of networks and access types, including DSL, ATM and Cable Modems. Mobile VoIP, alas, must wait for the availability of higher-rate air interfaces, such as EDGE and 3G, before it will be technically or economically practical.

Today's fixed NGN networks and tomorrow's 3G mobile networks face many of the same challenges, mostly resulting from (1) the packetization of the network, (2) variable QoS, and (3) the growing breadth of services. Both 2G and the PSTN were circuit switched networks, which, even with all their limitations as data networks, made for very predictable traffic and QoS management. Packet networks, despite their efficiency for transaction-oriented and variable-rate (mostly data) communications, complicate QoS management greatly. This is particularly true for delay-sensitive traffic, such as voice or financial transactions. Fortunately, many of these engineering and Operations Support Systems (OSS) challenges are already being solved for fixed NGNs, and the same methods and technologies can be applied to 3G mobile networks.

Beyond networks and technologies: operations

We believe that the underlying technology and engineering of NGNs can be applied to mobile 3G. But does the same hold for operations processes and paradigms?

Compared with their fixed network cousins, mobile network operators have always had a more flexible view, and less network-dependent process, of "provisioning". Activating a new mobile customer does not require provisioning a new dedicated circuit or transmission facility, as is the fixed paradigm. Instead, a customer need only be logically provisioned, in a database, at a web site, or in an HLR. This is the mobile concept of logical "service activation" on a pre-existing network. The NGN world is causing some fixed operators to slowly move to this new model but the mobile industry is already there.

But unlike today's networks, tomorrow's fixed and mobile networks alike will involve a far wider range of service types, quality levels³, pricing plans, and content mixes. Therefore the relatively simple "service activation" in 2G – creating HLR and billing records – must give way to a richer set of services profile options, just as the PSTN's world of "facility provisioning" will give way to logical services activation of the multitude of services available on each high speed "pipe".

As service richness drives revenues, it also holds the danger of driving up costs. Complex service options and complex mobile terminals⁴ could yield a dangerous

³"Quality" can be a very complex term. It can involve matching transmission latency to the type of service; providing levels of guarantee, and access priority, for example. These options will be discussed in an upcoming paper from Telcordia.

⁴It is very likely that tomorrow's 3G mobiles will be more like PCs in complexity – with an OS, client applications and multiple voice modules.

combination when mixed with the non-technical mass market of mobile users.

Witness, for example, the headache of an ISP that must suddenly talk novice users through the arcane configuration maze of Microsoft "dial up networking" or Mac OS Open Transport. Customer support and customer operations are already the dominant cost elements in mobile and ISP operators today – even though today's networks deal with relatively simple service sets. Clearly, a new paradigm is required to maintain high customer satisfaction (low churn) with reasonable support costs, as both the number of services and the complexity of mobile terminals spirals upward.

Looking into the root cause of those support costs, we find two culprits. The first is the complexity of customer equipment - either mobiles or PCs. The second root is enquiries and service changes that require the assistance of customer service representatives (CSRs). In either case, operators (Mobile or ISP) incur significant customer-support costs, and the customer is fundamentally inconvenienced.

Service management costs need not spiral upward forever. They can be reduced by software systems that manage customer self-service to a rich service profile, or "super HLR". If designed correctly this is a tremendous "win-win", resulting in lower costs and higher customer satisfaction. The second culprit, CPE complexity, ultimately leads to intelligent configuration management of CPE by a network based "OSS". Telcordia has already demonstrated that intelligent agents can isolate troubles without human intervention, and can extend the concept of managed version control to tomorrow's software-enabled mobile devices.

In conclusion

The 3G world will usher in many changes, from sheer growth to new radio and core network (packet) technologies. Yet the most profound impacts – both technically and operationally – may come from the plethora of services and service packages that 3G technology enables. This service proliferation and richness, more than IP technology itself, is truly the essence of the "mobile Internet".

Fortunately, not all of these technologies are entirely new, nor must their associated management challenges be solved entirely from scratch. Many of the same technologies, opportunities and challenges are part of the fixed world's evolution to "next generation networks", of which the first are actually being deployed commercially as I write. The technology and experience that comes from these early deployments, such as VideoTron's cable based VoIP network, Sprint's ION multi-media network, or SBC's clean-slate data network can be applied as well to tomorrow's 3G networks.

Telcordia is currently in the forefront of most of the major NGN and packet network deployments occurring around the world, providing engineering, network integration, and the world's first public-network-quality SoftSwitch and OSS deployments. As operators embark on the construction of NGNs and 3G networks alike, Telcordia provides a unique balance of vendor-independent objectivity and the expertise that comes from our heritage as the firm that invented or defined so many of today's and tomorrow's network technologies.

Telcordia is committed to providing leading edge service platforms that support the MWIF, 3GPP and Camel-3 standards; to a complete suite of OSS to "e-manage" growing mobile and IP infrastructure; and to the consulting, planning and network engineering that make tomorrow's 3G networks not only exciting, but reliable and economically successful as well.



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Grant Lenahan is Executive Director of Wireless Mobility Solutions for Telcordia Technologies, with responsibility for defining Telcordia's Mobile product and market strategies and for matching Telcordia's OSS, Service Platform technology, and engineering capabilities to the specific business needs of the dynamic Mobile wireless industry worldwide. His experience includes 15 years with Telcordia Technologies, working in such diverse areas as transmission engineering, data equipment analysis, video services design, and economic and operations analysis of new communications technologies / services. Before joining Telcordia in 1984, Grant also worked for GTE Lenkurt, Inc., GTE's transmission equipment manufacturing arm.

Grant received his BA in Economics and Mathematics (Computer Science) from Drew University (Madison NJ) and a joint Master's Degree from the School of Engineering and the Sloan School of Management from The Massachusetts Institute of Technology (MIT).

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